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Browsing Scan on Cyclone Affected Uprooted Plants in Bangladesh

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Abstract

A study was conducted in a devastating cyclone affected areas of Bangladesh, plants species 25 of different sample sizes randomly found in the spots were observed for uprooted trees, bamboo roots, etc. The 15 categories of uprooted tree/ plant containing 148 species including 9 bamboo clumps containing 223 culms were browsed and scanned for the studies. Soil-root zone of uprooted trees and clumps and soil-root volume of them were assessed at 11 variable conditions. Rootlets diameter, color and weight, etc of some bamboo at field condition was assessed. A total quantity of disturbed soil volume due to uprooting of bamboo clumps were found about 676 ft^3, which is equivalent to 19.0 ton of soil where soil-root ratio was 52:1 to 63:1. In situ detachment of soil-root mass caused of 848 ft^3 volume by trees /plants which amounts to about 78.0 ton. Relevant information in this regard is presented and discussed in the paper.
Key words: Bangladesh, cyclone-affected uprooted trees / bamboo.

Introduction

Prevalence of devastating cyclones, typhoons, hurricanes are common in the Asia Pacific Region. Bangladesh is also a country of that zone where cyclones occurred 19 times during 1981-1998, mostly at the transitional period of pre- and post monsoon. Coastal areas of Bangladesh are mostly affected due to these cyclones.On the April 29-30, 1991 a defenseless cyclone run over the areas with a speed of 225 km/hr and lashed the district of Chittagong, adjoining terrestrial areas and coastal belt of Bangladesh. Lost of life-human and animal kingdom, damaged tree and crop resources, destruction of human civilization, etc. were unrecoverable. Biodiversity was seriously threatened, birds and butterflies most. Losses of resources were assessed by concerned organization, death toll was about 0.14 M, crops loss value has been estimated at about 78.86 M dollar of 0.29 M acres land. Rubber plants were seriously affected in the rubber estates. A report showed that about 0.8 M plants among 1.47M were affected partly/fully: uprooted, branch or canopy was broken, etc. (Emdad, 2001). But information on uprooted plants and soil disturbed in this context had not been documented.

Roots, the major water absorbing organs of plants constitute about 20-25% of the tree biomass on weight basis (Voigt, 1960). Its study is difficult and costly opined different scientists, modern tracer technique like P^{32}, I^{131}, R^{36}, C^{14}, Ca^{45} and Cs^{137} to record expose large root systems without destroying some roots and its quantification is very costly too (Armson, 1979, Noordwijk,*et al*,1995). The root forms vary from plants to plants due to genetic control and partly by environmental factors. (Yorke**,** 1968). Kelela (1950) studied the root-soil volume ratio for Scots pine stands of different age (10 to 110 years) and found that ratio increases continually. Nye (1961) estimated the net annual contribution of dead roots (2.6 t/ha) under a tropical forest that significantly adds to the nutrient cycle in the ecosystem. Black spruce, a widely adaptable crop, 80% of its root remains in upper 60 cm and in many stands that were not found below 45 cm (Schultz, 1969).

During that unabated cyclone plant kingdom was seriously damaged. Canopy of trees was erased and uprooted due to cyclonic wind, which was vulnerable to the wind speed. Tree damaged due to cyclone was reported in the Dailies (Emdad, 1992). Root, a significant portion of trees in soil is still today remaining un-addressed. Because root exploration by excavating soil and separation of root from it are tidy, expensive and laborious. But root types of different trees are useful for site-specific tree selection and better management for maximization of yield. The defenseless and horrible cyclone uprooted trees, bamboo clumps and plants, which gave an opportunity to have a rapid look over them. The author took an advantage to look into that previously collected data on cyclone affected and uprooted trees/plants and reorganized the results for greater interest and presented in the paper.

Materials and Methods

Study area located in Chittagong, Bangladesh lies between 22^0-22^0. $50^/$ N latitudes and $91^0 50^/$ to 92^0 $20^/$ E latitudes. Ruminant bite study had been conducted in some part of cyclone affected areas that occurred on the 29-30th April 1991. The data were collected from the raised plantations or scattered planted in different locations. The uprooted and cyclone affected trees at patch / niche/ sites are located in Chittagong, as follows which were brought under study.

1.Bumbosetum of BFRI, Eastern part of West Hill, 2.Pine plantation, BFRI office campus, 3.Cashew nut plantations of East and West Hill, 4.Approach Road of BFRI to High way, 5.Circuit House Campus of Lalkhan Bazar, 6.Chittagong Railway Board Campus of Lalkhan Bazar, 7.Solashahar Railway Station site, 8.Bangladesh Forest College Campus of Solasahar, 9. Nursery site of BFRI and other, 10.Tikkapara (dwelling area) attached to the BFRI East Hill,11. Plantation of Keochia Silviculture Research Station.

Observation period was May 02-31, 1991. Recorded data includes 25 tree/plant species of 176 numbers and bamboo (223 nos) containing in the clumps listed in the table below that represents mostly of uprooted and affected trees of the studied area.

Table 1 containing some of the observed species in the field after cyclone in the study areas, Chittagong, Bangladesh.

Local /common name	Scientific name	Nos. of species	Local /common name	Scientific name	Species nos.
Bambusa species (B)			Teak	*Tectona grandis*	8
Farua	*B.* polymorpha	52	Raintree	*Albizia procera*	1
Sonalu	*D.longispathus*	40	Pine	*Pinus ocurpa*	40
Talla/toru	*B. tulda*	42	Toon	*Cedrela toona*	1
	B.giganteus	32	Gamar	*G.arborea*	2
Bhudum	*B.giganteus*	25	Mahagony	*S. macrophylla*	2
Lathi bansh	*D.strictus*	28	Eucalyptus	*E. camuldulansis*	9
Kalia/Kali	*O.nigrocillata*	23	Telsur	*Hopea odorata*	1
Baijja	*B. vulgaris*	40	Mingiri	*Cassia siamea*	1
Talla/toru	*B.tulda*	42	Simul	*Bombax ceiba*	-
Tree/plants			Akashmoni	*A. auriculiformis*	3
Cashew nut	*A..occidentale*	58	Krishnachura	*Delonix rejia*	2
Guavas	*Psidium guajava*	7	Papya	*Carica papaya*	4
*Coconut	*Cocos nucifera*	several	Dumur	*Ficus spp.*	2

Jam	*Sygygium cuminii*	2	Neem	*Azadiracta indica*	2
Jack fruit	*A. heterophyllus*	4	Banana	*Musa paradisica*	13
Champa	*M. champaca*	2	Tula	*Bombax ceiba*	3
Ata	*Annona reticulata*	2			

* Palm group has not been included in the list.

Instrument/tools used were hoe, shovel, measuring tap, scale, slide calipers, cylinder to collect soil and root together, open palm balance, information sheet, photographs, slides, etc.

Some parameters soil–root area and volume of uprooted bamboo, teak and other species were assessed. Samples of soil-root volume were collected by steel cylinder. One side of which was sharpen that easily set inside the soil-root mass with pressuring manually. Ddiameter of the cylinder was 5.05 cm and length 30 cm, resulted volume of which was 580.05 cm3. Representative intact block of soil and root volume samples were collected by cylinder from the uprooted portion of bamboo clumps setting the sampler at the uprooted part beneath the rhizome. The root was separated manual very carefully. Soil and root ratio was determined after O.D. weight. In case of bamboo 100 rootlets of 30cm length were weighed before and after drying at 65^{o} temperature. Soil- root volume ratio, etc were estimated in the field and in the laboratory. Collected 10 rootlets of bamboo and determined their diameter. But in case of other species, soil-root volume measured that adhered to uprooted tree root. Vertical extension of uprooted soil depth was assessed; soil-root volume was calculated by considering 1.33g of soil/$cm^{3.}$

Results and discussion

Data relevant to bamboo culms and gathered information are presented in Table 2 below and discussed.

Table 2: Uprooted area of ground down bamboo clumps and the protruded soil-root volume of the clumps at a bumbosetum in BFRI,Chittagong, Bangladesh.

Scientific names	Culms/ clump (Av. girth at 1 ft above ground)	Root color/dia meter (mm)	Slope	Disturbed soil-root zone ft^2) /volume (ft^3) per clump		Soil**:** root by OD wt (wt.100 roots of length 30cm
				d x r=ft^2	´ r^2 d = ft^3	
B. polymorpha	52 (33-36 cm)	Brown (2.07)	LS	1.5 X 3.9	72.0	52:1(83.4 g)
D.longispathus	40		LS	1.5 X 3.95	73.5	
B. tulda	42		MS	1.5 X 2.76	36.0	
B.giganteus	32 (36-40 cm)	Brown (1.82)	US	1.5 X 5.75	156.0	62: 1(120g)
B.giganteus	25		US	1.5 X 5.17	126.0	
D.strictus	28		US	1.5 X 3.9	72.0	
O.nigrocillata	23 (15-20 cm)	Black (2.01)	US	1 X 2.52	20.0	63:1(120g)
B. vulgaris	40	1.95	US	1 X 4.37	60.0	56:1
B.tulda	42	1.77	LS	1.5 X 3.56	60.0	60:1
Nos. of species	223	Total soil-root volume			676.0	

r=radii of the uprooted zone (ft) where d=depth of the uprooted disturbed soil that was protruded with root or uprooted extension vertically. L=Lower, S=slope, M=Middle and U=Upper

Total 9 clumps of uprooted bumbusa species of 18-20 years old were observed in situ. The site condition was degraded; sandy lower slope but the middle and upper slope was less sandy included with lateritic pan within 2-3ft-soil depth. Two uprooted clumps of *B. giganteus* in the upper slope disturbed soil-root most, where disturbed soil-root volume was highest. The circumference of the *B. giganteus* was highest too among the studied species followed by *polymorpha* and *O.nigrocillata*. The root diameter at field condition was found 1.77 mm to 2.07 mm. The average uprooted soil-root volume per culms has been recorded 0.88 to 5.04 ft^3 .Results indicate the culms density for each clump, where values stands for the space within culms, the highest results for wider culms spacing that depends on genetic character of each species because there was no management variation except the slope aspects. Bumbosetum development in such slope (45%) and in sandy soil/soil of lateritic pan is not suitable for bamboo cultivation. These findings could be brought to notice of the land user, bamboo cultivator or planners or policy makers. In a particular soil-root volume that ratio was recorded 52:1 to 63:1(by weight), it is a measure for root density of particular species. Estimated soil-root volume of 223 of culms was found 28.0 ton which showed a relation with uprooted zone of clump and protruded rootlets depth vertically in soil. The root color of bamboo is an interesting one which is brown for all the species but in case of *O.nigrocillata* that was black. Morphological part of bamboo was a matter of interest to the scientists and taxonomists (Alam, 1982). Though it is not the systematic study but the information is useful.

In the table 3 uprooted zone area coverage and the uprooted soil-root volume of 15 species among the 25 is presented. Observed species at different slope aspects were arranged and discussed below.

Table 3. Estimated soil –root area and volume of cyclonic affect uprooted species in Chittagong.

Land component (LC)	Radii coverage of uprooted Zone (r)			Extension of Uprooted zone=ft^2	Uprooted soil-root volume
Cashew nut					
LC (nos. obs.)	Max.	Min.	Av. of r	Av. of r x d = ft^2	´r^2 d x nos. of obs. = Total volume (ft^3)
US (34)	2.18	0.56	1.2	1.2 x 1.01	4.5 x 34 = 155
MS (17)	2.82	0.56	1.32	1.32 x 1.02	5.58 x 17 = 95
LS (5)	1.38	0.56	1.09	1.09 x 1.53	5.71 x 5 = 29
Eucalyptus					
Strip site(6)	3.0	1.71	2.24	2.24 x 2.16	34 x 6 = 204
Pine					
US (11)	2.19	0.56	1.17	1.17x 1.27	5.45 x 11 = 60
MS (11)	2.6	0.56	1.39	1.39 x 1.48	8.98 x 11 = 99
LS (15)	1.95	1.27	1.61	1.61 x 1.42	12 x 15 = 173
Guava					
LS (8)	1.12	0.28	0.61	0.61 x 1.07	1.25 x 8 = 10

Teak					
LS (7)	4.55	0.89	2.16	2.16 x 1.63	23.88 x 7 = 1 67
Jackfruit					
MS (3)	1.13	1.0	1.11	1.11 x 1.47	5.69 x 3 = 76
LS (3)	1.13	0.97	1.09	1.09 x 1.0	3.73 x 3 = 11
Banana plant					
LS (10)	1.1	0.9	1.0	1.0 x 1.0	3.14 x 10 = 31
A. auricuformis					
MS (2)	3.39	2.0	2.69	2.69 x 1.95	44.3 x 2 = 89
Mango					
LS (2)	1.38	0.79	1.08	1.08 x 1	3.66 x 2 = 7
Cotton					
LS (3)	1.69	0.56	1.13	1.13 x 1.33	5.33 x 3 = 16
Mahogani					
LS (2)	1.38	0.69	1.04	1.04 x 1.75	5.94 x 2 = 12
Black berries					
LS (2)	2.52	1.12	1.82	1.82 x 1.5	15.6 x 2 = 31
Neem					
MS (3)	1.38	1.38	1.38	1.38 x 0.83	4.96 x 3 = 15
Banyan tree					
LS (1)	9.77	-	9.77	9.77 x 3	900 x1 = 900
Rain tree					
LS (1)	6.77	-	6.77	6.77 x 4	5751x = 576
Krishna chura					
MS (2)	1.58	1.13	1.35	1.35 X 0.75	4.29x2 = 9
Total spp.155				Total soil root volume	= 2765.0

* Av. of protruded soil depth with root=depth=d ft

Teak seven uprooted teak were assessed .The studied teak species were of age group 8 to 100 years, of them two were of age group >100 year and the rest of 15-20 years, occupying the lower slopes of niches. The oldest uprooted teak encircled the maximum area of 4.55ft where teak of lower age group showed the lowest uprooted area. Highest soil disturbed occurred by the uprooted teak. The roots were flat rooted, secondary roots were strong and tertiary and finer roots were less exposed. An uprooted teak at Chittagong Circuit House Campus (CCHC) showed that feeder root and heartwood has been rotten. The tree of over mature showed be harvested otherwise that would loss economic value. The estimated result of the table is not the end of conclusion as that may be associated with many factors, like pathogenic.

In uprooted zone of tree species teak root extension was most followed by pine, jackfruit, cashew nut and guava but least in banana respectively. Soil- root volume was found highest in pine in the uprooted lower slope. In case of slope aspects vertical root extension was highest in pine in lower slope followed by jackfruit and cashew nut. Vertical extension of root and the soil-root volume was highest in pine except teak. But there was age variation in between teak and pine. Result within teak in this context, not comparable because there was wide variation of age and number of observation. In *Pinus ocurpa*- root density was observed which showed highest density amongst the tree species and least in cashew nut. Root protruding and densities in guava

and jackfruit was lesser than cashew nut, pine and teak. Horticultural crops papaya, banana, guava, black barriers, etc. was uprooted and broken, among them guava was mostly uprooted but broken stump/branches was least.

Due to uprooting tree/plants disturbed soil-root volume but soils displacement therein occurred was not estimated. Those cyclone-affected trees disturbed a total of 2765 ft^3 soil-root volume, which equals to about 78.0 ton of soil included with root. Here it is necessary to note that soil-root volume detached from its soil due to uprooting caused soil displacement but that varied from species to species and of age. Highest detachment soil-root volume was recorded for banyan tree, teak and rain tree which was respectively 900, 576,576 ft^3 among the assessed samples. These species disturbed soil- root volume of about 25,16 and 16 respectively. Tap root, secondary and tertiary root of these trees were rotten and even the heart root. Similar over mature eucalyptus with rotten root and heart wood was uprooted in the Forest Academy gate.

In a roadside strip plantation eucalyptus root penetration vertically might be considered highest, as well as root density was not less than pine. But in the Keochia Silvicultural Research Station eucalyptus plantations of varying age group was not uprooted, branches was least affected. Banana plant, individually disturbed soil less in quantity but in clusters that worth mentionable in shallow soil. *Butea monsperma*, *Bombax ceiba* and *Delonix rejia* were least uprooted but branches, most which caused problems in electric lines, these plants should not be planted near at electric line. *Cedrela toona*, a tap rooted tree with secondary, tertiary and quarternary extension was observed in soil depth up to 4 ft, which should be planted in deep soil. The Palmyra palm and cocoanut have been observed to withstand the cyclonic affect, not a single species of those were uprooted by cyclone storm while did the field work in the anthropogenic soil, in the coastal belt, in the homestead, etc. It is well recognized to planting palm group in the coastal belt in Bangladesh as a crop of shelterbelt, further it is emphasized to plant more.

Conclusions

Site specificity and suitability should be considered emphasized before initiating planting program. Scanned data support to infer that teak and bamboo species should not be planted in shallow soil or steep slope. Moreover, logging of crops/ harvesting before decaying of its heartwood is suggested

Reference

1. Armson, K. A. 1979. Forest Soil: properties and process. Uni. of Toronto Press, 390 pp.
2. Alam, M.K. 1982. A Guide to Eighteen Species of Bamboos from Bangladesh (BD), Govt. of BD, BD Forest Research Institute, P.B. No: 273, Chittagong. 35pp
3. Emdad Hossain, A.T.M. 1992. Ghurni Jharey Khatigrastha Gach Pala Neye Duti Katha (in Bengali). (Few words on Cyclone Affected Trees). Pub. In a Daily news paper of Chittagong,The Purba Kone,; April 28, (Reprinted in one Journal & in a daily).
4. Emdad Hossain, A.T.M., 2001. Effect of NPK Fertilizers on the Latex Yield of *Hevea brasiliensis* Muell.Arg. in a Rubber Estate., Ph. D Thesis, Dept. of Soil, Water and Environment, University of Dhaka: 246 pp.
5. Noordwijk, M.Van; Spek ,L.Y. and Purnomosidhi,P.1995.Quantifying shallow roots: tree geometry makes root research easy. In. Agro- forestry Today, April – June 1995. ICRAF House, United Avenue, Gigiri, P.B.No.30677, Nairobi, Kenya, 7 (2): 9-12.
6. Voigt, G.K.1960. Distribution of rainfall under forest stands. For Sci. 6:2-10
7. Phillis, W.S. 1963 Depth of roots in soil. Ecology 44:424

8. Yorke, J.S. 1968. A review of techniques for studying root systems. Canada Dept. For. and Rural Develop. Info. Rep. N-X-20, St John's
9. Kelala, E.K.1950. The horizontal roots of pine and spruce stands. Acta For. Fenn. 57:1-79
10. Nye, P.H.1961. Organic matter and nutrient cycles under moist tropical forest. Plant and Soil 13:333-46
11. Schultz, J.D. 1969. The vertical rooting habit of black spruce, white spruce and balsam fir. Ph.D dissertation, Univ. Michigan. University Microfilms Inc., Ann Arbor

DESCRIPTION OF SLIDES SCENARIO

Description of Slides mostly uprooted trees taken during 12.05.91 to 15.05.91.

Slide No.	Local/scientific name	Estimated Soil-root volume (length x breath x root protruded soil,cft) and some relevant information
1.	Farua/ B. Polymorpha	8 X 6 X 1.5=72, BFRI bambosetum. Clump was ground down to the Northwest direction. Sandy soil. No significant root indication in uprooted place. Fibrous root.
2.	Budum/ B. Gigantus	12 X 8 X 1.5=144,BFRI bambosetum. Clump was ground down to the N-W direction. Lateritic pan was present beneath the roots zone. No significant root hair has been marked in the uprooted place.

3.	Tulda at Line No. 1	9 X 7 X 1.5=94.5,BFRI bambosetum. Clump was ground down to the N-W direction. No significant root hair was marked in the uprooted place the clump was displaced.
4.	Wood logs/	BFRI campus and near to the SRD; the wood logs were pilled by the BFRI authority. Major specie Kajubadam, pine eucalyptus, bamboo etc. were uprooted
5.	Minjiri/ Cassia siamca	9 X 6 X 2 = 108 cft, Northern side of DFC's quarters. Ground down to the western direction. Tape root bend, black root; secondary many
6.	Root helps In soil conservation	Attached to the FC's playground. Many fine and few medium roots were in hanging condition there loose sandy soil particles have been shed down. Soil beneath the root was cut but due to root zone and their anchorage help to remain in equilibrium to the soil surface.
7	Mahogani/ *Switenia mahogany*	3 X 2 X 1.5 = 9 cft, BFRI entrance roadside. Ground down to the northwest direction Exposed deep-rooted secondary root, whitish color. At the end of secondary roots there were roots, look like hen's leg.
9.	Teck/ *Tectona grandis*	10 X 5 X 1.5=75 cft , BFRI arboretum. Ground down to the N-W direction shallow root system. Many horizontally distributed secondary root with tertiary. No root debris in uprooted place.
10.	Rain tree	16' X 9' X 4 =576 cft , Near to the solasahar rail station. Ground down to the Western direction. Many secondary roots like a tape root traversed a long horizontal distance. No deep root mark. Beneath the root, bricks debris. Perhaps the seedlings were planted on a small pile of soil.
11.	Ground down Banyan tree of 16.	Scenarios of destroy. Older ness might cause to damage to the assets. The over mature banyan tree has fallen down to the kitchen of the circuit house which destroyed the same. So, it is necessary to remove the tree for use in time but before their two dimensional loss; loss of asset and injured to others.
12.	Teak (20^{th} circuit hous campus)	21 X 12 X 3=756 cft, Western side of Solashar Rail Station ground down to the western direction very strong horizontally distributed secondary root. (Interestingly the teak was sold by Tk. 530 only).
13.	Root cut of simul tula	Near at Lalkhan Bazar. Eastern side of Tiger pass bound road. The roots have been butcherly cut down but trying to sprout for human interest.
14.	Banyan tree	25 X 12 X 3=900 cft, At Chittagong circuit house campus. Ground down to the N-West direction. Over mature tree. Root was moribund. Shallow root. Many horizontally distributed secondary root. Tertiary and hair root about to disappear.
15.	Teak	15 X 12 X 3 cft ,Circuit House campus, over mature tree. Many Secondary and tertiary root. Total tree: 20/21 planted perhaps in 1870. Fiber roots mostly decayed.

16.	Nursery	Cyclon affected ept. At BFRI Nursery. In set Dr. S.P. Paul has been observing the condition of the seedlings.
17.	Kajubadam	8X2.5X1.5 cft, BFRI's East Hill slope. Tap root with few secondary and few tertiary roots.
18.	Cocoanut	DFC campus. Hill summit cocoanut plant, hurricane affected twig leaves of other trees. In view focuses that leaves of palm are least affected.
19.	Eucalyptus	FC campus. N-E corner of field boundary. Plant has planted in 1967. Root decomposed, and moribund, over maturity or may be diseased root from the beginning these has cause to the breakage of root. It also damaged the wall and electric pole. Decomposed debris are being seen in heart wood.
20.	Pine/P. Ocarpha	SRS Keochia. Plantation of 1983. All most all the plants (70%) were swept down to the north direction. It is attached to the eastern side of the staff quarter. Root system was not much strong but more branches and leafy and also more affected than P. carebea.
21.	Pynkado/ Xylia dolabriformis	5.6 X 5 X 1.5 cft, SRS Keochia. Plantation of 1968. Concretionary layer in the subsoil. Leafy, black root, short taproot broken. Many horizontally distributed secondary root but feul in vertical direction. Few tertiary and fibrous root.
22.	Eucalyptus/ E.camaldulensis	Unknown provenance of eucalyptus plantation 1979. No break down or uprooting of the species. Growth poor. Height 20 to 25 ft, girth 1.5 to 2.5 ft station officer also agreed that the species was resistant to the wind.
23.	Tikka,a charcoal product and by product of fueling materials	Tikka, one type burning material for "dhup" and Tobacco, which are made from charcoal. It helps in livelihood of some poor professional of this type.7/8 kg charcoal buys by TK. 35/40. 1 kg charcoal produce 1000 tikka. Which, selling price: 12 TK/ Thousand in wholesale. & 20/25 TK. In retail (use of wood debris)

Table: Soil root volume of cyclone affected trees of April 29-30, 1991 in Chittagong.

SL.	Species	Nos.	Position/L	Soil depth X Length X Berth of

NO.			ocation	uprooted area =Soil-root volume, cft
E-F type				
1.	Gamar	1	MS	1 X 2 X 3 = 6
E-D type				
2.	Banana	5	LS	1 X 1 X 1 = 1
3.	Bamboo clump	1	LS	1’ X 5’ X 1 = 5 X5=5
4.	Teak	1	LS	1.5’ X 2 X 3’ = 9
5.	Teak	1	LS	1 X 2 X 2 = 4
6.	Teak	1	LS	1 X 2.5 X 1 = 3
7.	Cotton	1	LS	1 X 1 X 1 = 1
8.	Cotton	1	LS	2 X 3 X = 18
9.	Black berries	1	LS	2 X 5 X 4 = 40
F type, Southern side				
10.	Guava	1	LS	1 X 5 X 2 = 10
11.	Guava	1	LS	1 X 1 X 1 = 1
12.	Guava	1	LS	1 X 1 X 1 = 1
13.		1	LS	1 X 1 X 1 = 1
14.	Guava	1	LS	1 X 1 X 1.5 = 1.5
15.	Guava	1	LS	1 X 1 X 1.5 = 0.5
16.	Guava	1	LS	1.5 X 1 X 1 = 0.5
17.	Banana	2	LS	1 X 1X 1 = 1
18.	Cotton	1	LS	1 X 2 X 2 = 4
19.	Jackfruit	1	LS	1 X 2 X 2 = 4
20.	Black Berries	1	LS	1 X 2 X 2 = 4
	G-H type			
21.	Ata	2	LS	1.5 X 1 X 1 = 0.5
22.	Mango	1	LS	1 X 2X 3 = 6
23.	Guava	1	LS	1 X 1 X 2 = 2
24.	Jackfruit	1	LS	1 X 3 X 1 = 3
25.	Mango?	1	LS	1.5 X 4 X 2 = 12
26.	Badi	1	LS	1.5 X 3 X 2 = 9
27.	Mander	2	LS	.5 X 1 X 1 = 0.5
F-E type				
28.	Papya	4	LS	.5 X 1 X 1 = 0.5
29.	Banana	5	LS	1 X 1 X 1 =5
West Hill, summit?				

30.	Kajubadam	1	US	1 X 4 X 2 = 8
31.	-do-	1	MS	1 X 2 X 1 = 6
32.	-do-	1	MS	1 X 1.5 X 1 = 3
33.	-do-	1	MS	1 X 1 X 1 = 1
34.	-do-	1	US	1.5 X 4 X 2 = 12
35.	-do-	1	US	0.5 X 1 X 1 = .5
36.	-do-=	1	US	0.5 X 1 X 1 = .5
37.	-do-	1	US	0.5 X 2 X 1 = 1
38.	-do-	1	US	1 X 3 X 1.5 = 4.5
39.	-do-	1	US	2 X 2 X 1 = 4
40.	-do-	1	US	1 X 2 X 1.5 = 1
41.	-do-	1	MS	1 X 3 X 1.5 = 4.5
42.	-do-	1	MS	1 X 3 X 1 = 3
43.	-do-	1	MS	1 X 2 X 3 = 6
44.	-do-	1	US	1 X 1 X1 = 1
45.	-do-	1	US	1.5 X 3 X 1 =1.5
46.	-do-	1	US	.5 X 1 X 1 =.5
47.	-do-	1	US	1 X 2 X 1 = 2
48.	-do-	1	MS	3 X 5 X 5 =
49.	-do-	1	MS	1.5 X 5 X 2 = 15
50.	-do-	1	LS	1.5 X 3 X 2 = 9
Akashmoni , plantation of 1969, North Hill / DFRI 's building				
51.		1	MS	1.9 X 8 X 4.5 = 63
52.	-do-	1	MS	2 X 5 X 2.5 = 25
53.	Pine	1	LS	1.3 X 4.5 X 1.5 = 8.44
54.	-do-	1	LS	2 X 4 X 3 = 24
55.	-do-	1	LS	1 X 4.5 X 2 = 12
56.	-do-	1	LS	1 x 3.5 X 3 = 10.5
57.	-do-	1	LS	1 X 3 X 1.7 = 4.74
58.	-do-	1	LS	1 X 4 X 1.5 =
59.	-do-	1	LS	9 X 4.5 X 1.5 = 5.06
60.	-do-	1	LS	1 X 3 X 2 = 6
61.	-do-	1	MS	2 X 8.5 X 2.5 =
62.	-do-	1	MS	1 X 4.5 X 2 =9
North Hill				
63.	-do-	1	US	1 X 5 X 3 = 15
64.	-do-	1	US	1 X 2 X 1 = 2
65.	-do-	1	US	1.5 X 2 X .5 = 1.5
66.	-do-	1	US	1 X 2.5 X 1.5 = 3.75
67.	-do-	1	US	1 X 4 X 1 = 4
68.	-do-	1	US	1.5 X 3 X 2.5 =
69.	-do-	1	US	1 X 1 X 1 = 1

70.	Champa	1	US	8 X 5 X 1.5 = 60
71.	Krisne Chhura	1	US	0.5 X 4 X 1 = 2
72.	Kajubadam	1	US	7 X 2.5 X 2.5 =3.65
73.	-do-	1	US	2 X 3 X 1 = 3
74.	-do-	1	US	8 X 4 X 1.5 = 4
75.	-do-	1	US	9 x 2 X 1.8 = 2.7
76.	-do-	1	US	8 X 1.5 X 6 =
77.	-do-	1	US	7 X 2.5 X 1.8 = 2.6
78.	-do-	1	US	1 X 3.10 X 2 = 7.66
79.	-do-	1	US	10 X 2 X 1 = 1.66?
80.	-do-	1	US	0.8 X 2 X 1 = 1.6
81.	-do-	1	US	4 X 2.3 X 1.5 = 4.5
North Hill				
82.	-do-	1	MS	1 X 4.6 X 3 = 13.5
83.	-do-	1	MS	1 x 4 x 1.4 = 5.32
84.	-do-	1	MS	2 X 2 X 1.4 = 5.32
85.	-do-	1	LS	2 X 7 X 4.5 = 63
86.	Chapalish	1	LS?	2 X 6 X 3 = 36
87.	Eucalyptus	1	-do-	2.5 X 7 X 4 = 70
88.	Pine	1	-do-	2 X 4 X 2 = 16
89.	Kajubadam	1	-do-	1 X 2 X 2 = 4
90.	Pine	1	-do-	2 X 6 X 2 = 24
Western side of DFRI's Hill, N-W, LS				
91.	Teak	1	US?	1.9 X 1.3 X 5 = 48.7
92.	Dumur	1	US	1.5 X 3 X 3 = 13.5
93.	Pine	1	LS	2x 4 X 3 = 24
94.	-do-	1	MS	1 X 2 X 1.5 = 3
95.	-do-	1	MS	2 X 4 X 2 = 16
96.	Kajubadam	1	LS	1.5 X 3 X 1 = 9
97.	Dumur	1	US	1.5 X 3 X 2 = 9
98.	Kajubadam	1	LS	1.9 X 6 X 2.5 = 26.25
99.	Pine	1	US	1 X 2 X 2 = 4
100.	Banana	1	US	1 X 1 X 1= 1
101.	Kajubadam	1	MS	1 X 1 X 1 = 1
102.	**Jackfrui**t	1	MS	1.5 X 2 X 2 = 6
***Right to NE side of shelves towards, 1970**				
103.	Pine	1	EH, US	2.5 X 5 X 3 = 22.5
104.	-do-	1	-do- MS	1.5 X 2 X 2 = 6
105.	Krisna Chura	1	MS	1 X 3X 2.6 = 7.8
106.	Pine	1	MS	1.5 X 2.5 X 1.5 = 5.62

107.	-do-	1	MS	1.3 X 2.8 X 2 = 4.5
108.	Chatim	1	LS	1 X 3 X 2 = 1.8
109.	Pine	1	LS	10 X 3 X 3 =
110.	Pine	1	LS	0.5 X 5 X 2 =15
Side South to EH. Towards rail line, plantation of 1970				
111.	Teak	1	LS	1.5 X 5 X 4 = 30
112.	Pine	1	LS	1.8 X 3 X 3 = 16.2
113.	Kajubadam	1	LS	1 X 3 X 2 = 6
114.	Pine	1	US	1.5 X 1.7 X 1 = 2.5
115.	Kajubadam	1	US	1 X 4 X 1= 4
116.	Pine	1	US -1970	1 X 2.5 X 1.5 = 3.75
117.	-do-	1	MS	2 X 3 X 1 = 6
118.	-do-	1	MS	1.5 X 3 X 2.5 = 11.25
119.	-do-	1	MS	1.5 X 3 X 1.5 = 6.75
120.	-do-	1	LS	1.5 X 3.5 X 2 = 10.5
121.	Kajubadam	1	MS	1.5 X 4.5 X 2 = 13.5
122.	-do-	1	MS	1 X 3.5 X 2.5 = 8.75
123.	-do-	1	US	2.5 X 10.5 X 8 = 43.6
124.	Neem	1	US	1.5 X 3 X 2 = 9
E. Side of E. Hill to Forest College				
125.	Eucalyptus	1	LS	1 X 1X 1 = 1
126.	Minjiri	1	LS	1.5 X 10 X 5 = 75
127.	Akashmoni	1	MS	1.5 X 4 X 3 = 18
128.	Eucalyptus	1	LS	
BFRI Arboretum				
129.	Teak	1	LS	3 X 10 X 5 = 150
Security gate to rode side of BFRI				
130.	Toon	1	Rode side	3 X 9 X 6 = 126
131.	Eucalyptus	1	Ditto	3 X 7 X 3 = 63
132.	-do-	1	Ditto	2 X 5 X 2.5 = 20
133.	Mahogani	1	Ditto	2 X 1 X .5 = 2
134.	Eucalyptus	1	Ditto	1.5 X 5 X 3 = 22.5
135.	-do-	1	Ditto	3 X 5 X 3.5 = 25
136.	-do-	1	Ditto	2.5 X 5 X 2 = 25
137.	Mahogani	1	Ditto	1.5 X 3 X 2 = 9
138.	Teak	1	Ditto	1.5 X 1 X 1 = 1.5
139.				
140.				

Hill attached to the South side of PPD, MS				
141.	Gamar	1	MS	1 X 3 X 2 = 6
142.	Pine	1	MS	1 X 1X 1= 1
143.	Kajubadam	1	MS	.5 X 5 X 2 = 5
144.	-do-	1	MS	.5 X 2 X 2 = 2
145.	-do-	1	MS	1 X 2 X 3 = 6
146.	-do-	1	MS	.5 X 1 X 1 = 0.5
147.	Mango	1	MS	1 X 1 X 2 = 2
148.	Neem	2	MS	.5 X 2 X 3 = 3
West Hill, East Slope, US				
149.	Pine	2	LS	1.5 X 3 X 1.5 = 6.75
150.	Eucalyptus	1	LS	.5 X 4 X 2 = 4
151.	Kajubadam	1	US	2 X 5 X 3 = 30
152.	-do-	3	US	1 X 1X 1 = 1
153.	-do-	1	US	1 X 2X 2 = 4
154.	-do-	1	US	.5 X 1 X 2 = 2
155.	-do-	1	US	1 X 3 X 2.5 = 7.5
156.	-do-	1	US	1 X 2 X 2 = 4
157.	-do-	1	US	.5 X 1 X 1 = 0.5
158.	-do-	1	US	1.5 X 3 X 1 = 4.5
159.				
160.				
161.				
162.				
163.				
164.				
165.				
166.				
167.				
168.				
169.				

It was observed that tap and heart roots particularly during steam flow from high intensity precipitation passes down to the external surface of the roots from the root collar. Water channeling to depth in the soil in this system reflect the distribution of these vertical roots.

. Phillips (1963) reported a root depth of 53m for the species Prosopsis juliflora (swartz) D.C., which was exposed during a mining excavation in Southern

Arizona. This wonderful information on root Prosopsis juliflora, originally introduced for desertification control, is spreading wildly and encroaching on the habitat of natural occurring vegetation – much of which has proven medicial properties and which in a source of many valuable Non-Timber forest products.

Study of Shea (1973) in natural jazk pine found that often 75% of lateral root extension was achieved in the first eight years of growth and similar rapid elongation was found to tap root development. In case of Douglas fir roots Eis (1970) found the similar pattern of extension. He concluded that over all extension occurred after 15-20 years of age.

In addition of tap, vertical roots or sinkers develop from horizontal roots. Roots develop from horizontal and vertical, these an offer called **ob roots**. Due to mechanical barrier or ground water table, roots development impeded and series of secondary roots development occurred.